

## WHAT IS CLAIMED IS:

1. A method of maintaining frame synchronization in a multicarrier modulation transmission system in which a synchronizing frame containing a synchronizing pattern is periodically transmitted, comprising the steps of:
  - 5 storing complex amplitudes of the synchronizing frame;
  - correlating the complex amplitudes of the synchronizing frame with stored information representing the synchronizing pattern, thereby to produce a correlation result; and
  - determining whether the correlation result falls below a threshold value, indicating a loss of frame synchronization, and in this event:
    - 10 performing a plurality of correlations between the stored information and the stored complex amplitudes in each case multiplied by a respective complex value representing a respective complex derotation of the stored complex amplitudes, each complex derotation corresponding to a respective time shift of the synchronizing frame, thereby to produce a plurality of correlation results each corresponding to a respective time shift;
    - determining from the plurality of correlation results a time shift for restoring frame synchronization; and
    - adjusting a frame boundary in accordance with the determined time shift to restore frame synchronization.
2. A method as claimed in claim 1 wherein each correlation result is produced by multiplying each complex amplitude by a corresponding complex amplitude from the stored information representing the synchronizing pattern, and summing the real parts of the complex products.
- 25 3. A method as claimed in claim 2 and including the step of weighting the complex amplitudes being multiplied.
4. A method as claimed in claim 3 wherein the weighting for each complex amplitude being multiplied is dependent upon a signal-to-noise ratio of a multicarrier channel associated with the respective complex amplitude.
- 30 5. A method as claimed in claim 1 wherein the step of determining from the plurality of correlation results a time shift for restoring frame synchronization comprises determining a best correlation result from the plurality of correlations and selecting the time shift corresponding to the best correlation result if the best correlation result exceeds a second threshold value.

6. A method as claimed in claim 5 wherein the second threshold value is greater than the threshold value for indicating a loss of frame synchronization.
7. A method as claimed in claim 1 for a discrete multitone modulation transmission system, including the steps of:
  - 5 using a tone having a predetermined frequency for frequency synchronization between a transmitter and a receiver of the system;
    - at the transmitter, converting complex amplitudes in the frequency domain into time domain values using an N-point Inverse Fast Fourier Transform;
    - sampling time domain values at the transmitter at a sampling frequency which is j
    - 10 times the predetermined frequency, where j is an integral power of two; and
    - at the receiver, converting time domain values into complex amplitudes in the frequency domain using an N-point Fast Fourier Transform;
    - wherein each of said complex derotations corresponds to a respective one of  $N/j$  time shifts within the duration of one frame.
- 15 8. A method as claimed in claim 7 wherein the synchronizing frame is periodically transmitted once every Q frames, where Q is an integer greater than  $N/j$ .
9. A method as claimed in claim 8 wherein said plurality of correlations comprise  $N/j$  correlations corresponding to time shifts in either direction up to half the duration of one frame.
- 20 10. A method as claimed in claim 9 wherein  $N = 512$ ,  $j = 8$ , and  $Q = 69$ .
11. A method as claimed in claim 7 wherein the step of determining from the plurality of correlation results a time shift for restoring frame synchronization comprises determining a best correlation result from the plurality of correlations and selecting the time shift corresponding to the best correlation result if the best correlation result exceeds
  - 25 a second threshold value.
12. A method as claimed in claim 11 wherein the second threshold value is greater than the threshold value for indicating a loss of frame synchronization.
13. A method as claimed in claim 7 wherein each correlation result is produced by multiplying each complex amplitude by a corresponding complex amplitude from the
  - 30 stored information representing the synchronizing pattern, and summing the real parts of the complex products.
14. A method as claimed in claim 13 and including the step of weighting the complex amplitudes being multiplied.

15. A method as claimed in claim 14 wherein the weighting for each complex amplitude being multiplied is dependent upon a signal-to-noise ratio of a multicarrier channel associated with the respective complex amplitude.
16. A multicarrier modulation transmission system receiver comprising:
- 5 a Fast Fourier Transform (FFT) unit for transforming time domain values into complex amplitudes in the frequency domain;
- a buffer for supplying received time domain values to the FFT unit in accordance with a frame boundary;
- 10 a correlator for correlating complex amplitudes of a synchronizing frame of the system with a synchronizing pattern stored at the receiver to produce a correlation result; and
- 15 a control unit responsive to the correlation result being below a threshold value to adjust the frame boundary by a time shift determined by performing a plurality of correlations between the stored synchronizing pattern and the complex amplitudes in each case multiplied by a respective complex value representing a respective complex derotation of the complex amplitudes corresponding to a respective time shift of the synchronizing frame, and selecting the best correlation result.
17. A receiver as claimed in claim 16 and including a multiplier for weighting the synchronizing pattern in dependence upon signal-to-noise ratios of the multicarrier channels.
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